Contributions from the Botanical Department of the
University of Nebraska.

NEW SERIES, VII.

EVOLUTION AND CLASSIFICATION.

By Charles E. Bessey, Ph. D.

[*From the Proceedings of the American Association for the Advancement of Science, Vol. XLII, 1893.*]

Read Aug. 17, 1893.
Distributed July 6, 1894.

ADDRESS

BY

CHARLES E. BESSEY,

VICE-PRESIDENT, SECTION G,

BEFORE THE

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

AT THE MADISON MEETING,

AUGUST, 1893.

PRINTED BY
THE SALEM PRESS,
SALEM, MASS.,
1894.

ADDRESS

BY

CHARLES E. BESSEY,

VICE PRESIDENT, SECTION G.

EVOLUTION AND CLASSIFICATION.

MEMBERS AND FELLOWS OF THE SECTION OF BOTANY:

IT is fitting in this address, which opens the work of the new section of botany, when for the first time in the history of the Association we meet officially as a body of botanists, that I should give voice to thoughts which have come to many of us during these later years. As we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple Botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialization so noticeable year by year there is a corresponding lack of coördination of work. To this lack of coördination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The work of the morphologist and the physiologist no less than that of the professed systematist all find their final expression in classification. The idea which has sometimes found favor among botanical workers, that there are some departments of botany which have nothing whatever to do with classification, is entirely erroneous. It may be true that a particular worker may make no such use of his results, but it is true nevertheless, that his results will be used and given place and meaning in the great structure which we know as the System of Plants. We must not overestimate the value of the work done in particular fields. No one to-day will deny the importance of the work of the histologist who constantly surprises and astonishes us with the depth of insight which he attains of the minute structure of the cell. We follow the morphologist as he skillfully traces the homologies of organs in related groups of plants, and we watch with delight the cunningly devised experiments of the physiologist whereby he is enabled to penetrate further and further the mystery of plant life. The facts of histology, morphology and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science: we may do likewise with the facts which the morphologist has discovered: we may make a classification of all the known physiological facts, but beyond and above these lies the greatest grouping of all, the grouping in orderly sequence of the organisms themselves whose histology, morphology and physiology we have studied. Do not misunderstand me. When I claim the first place in importance for the classifiacation of living things, do not for a moment suppose that this implies first in point of time in the study. Because the superstructure is the culmination of the building, we do not necessarily begin with it and leave the foundation until later.

But all this is preliminary, and I have referred to it merely to be sure that we are fully agreed as to certain fundamentals.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master mind of Darwin. In its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. The present similarity of two organisms is not enough to determine their relationship, or place in a system.

Common origin must be inferred in order that relationship shall be assumed.

Furthermore, in the light of evolution we now see the meaning of many reduced structures whose significance was formerly not at all or but vaguely understood, The rudimentary stamens of the Labiatæ, and Scrophulariaceæ, the rudimentary ovules of some Compositæ and Gramineæ, the rudimentary calyx of most Umbelliferæ and many Compositæ are no longer difficult to understand. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Even in those cases where the organism itself has advanced, frequently some of its organs have undergone degeneration. Still more frequently the whole organism has suffered structural degradation, and we commonly assign it a lower place. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the "fungi," where the degradation has gone so far that their relationship has to a great degree been obscured. Among flowering plants we have numerous instances of degradation through parasitism, as, for example, the species of Cuscuta, the Orobanchaceæ, Loranthaceæ, Rafflesiaceæ, Balanophoraceæ, etc. In the dodder we have no difficulty in recognizing a degenerated morning glory; the broom-rape is apparently a degenerated figwort, and the relationship of the mistletoe to the Santalaceæ is equally plain. The Rafflesias and the Balanophorads have suffered such great degradation as to almost totally obscure their affinities.

But there are also many cases of a catagenesis not due to a dependent habit, in which we have evidence of simplification from a more complex structure. Thus in the willows and poplars where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of the willow is simple by a degeneration from a higher type, probably a tricarpellary or penta-carpellary type, by the loss of its floral envelopes and stamens or pistils. Puzzling as the question of the relationship of the willows has been to systematists, it is no longer difficult to recognize in them, when viewed in the light of evolution, apetalous, declinous Tamariscineæ.

The knotworts, amaranths, chenopods, and polygonums are likewise simplified forms of well known higher types. Every botanist has recognized the close relationship of the knotworts (Illecebraceæ) to the pinks (Caryophyllaceæ) from which they differ mainly in being apetalous. So close indeed is the relationship between these two groups that in earlier editions of Gray's Manual they were regarded as one, and it was only with violence that they were taken asunder. The amaranths (Amarantaceæ) evidently represent a similar scarious and apetalous modification of a higher type allied to the pinkwort Family. In the chenopods (Chenopodiaceæ) there is a similar apetalous, but not scarious reduction in the perianth, and in other characters they are so much like the amaranths that they are always regarded as closely related. In the polygonums (Polygonaceæ) the simple little flowers are so only by reduction from a higher type. Here the flowers have suffered little if any more reduction from the caryophylline structure than have the knotworts (Illecebraceæ), and like the latter, are apetalous, with a one celled, one-ovuled, pluricarpellary ovary. The polygonums should never have been separated from their relatives the pinks, simply because they have undergone such comparatively slight modifications in structure.

It would be easy to multiply examples like the foregoing not only among the Dicotyledons, but also among the Monocotyledons, where the rushes, aroids, palms, sedges and grasses are successively greater reductions and simplifications of the lily type. It is, however, unnecessary to prolong this part of the discussion. Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

In the attempts to arrange in orderly sequence the vast assemblage of living things which to-day people the earth we must constantly keep in mind the fact that they have been evolved from preexisting forms. I need not now, before a body of scientific men, speak of evolution as an hypothesis: for we know it as a great biological fact, as to the existence of which there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a system, there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants, at the hands of English and American botanists. We are all familiar with the usual sequence of the families, first the Dicotyledons, followed by the Monocotyledons. In the former we have in succession the Polypetalæ, Gamopetalæ and Apetalæ, the particular sequence being in Polypetalæ from those with several, separate and superior ovaries to those with one compound inferior ovary, while in the Gamopetalæ we begin with those with an inferior much modified ovary, and proceed to those with a superior less modified ovary. In the Apetalæ we find first the plants having a superior ovary, than those in which it is inferior, and we finally reach a confused aggregation of families in which some have the ovary inferior, while others have it superior. When this sequence was first outlined the Ranunculaceæ and their relatives were regarded as representing the highest type of the Dicotyledons, and the series was therefore a descending one, but this was so obviously an error that without any material change in the sequence a new interpretation was given it. We now ascend from the Ranunculaceæ, through the Polypetalæ, and continue the ascent until we reach the Compositæ, after which we begin a descent to the Labiatæ, thence passing into the Apetalæ we rise for a distance, and then descend again to the Amentaceæ. Nothing more unnatural could have been readily devised to represent the Dicotyledons than this undulating series, over whose serpentine path the young botanist wearily and confusedly trudges in the company of older systematists who patiently endure the irregularities and inconsistencies of the familiar path. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution they are still using so crude an arrangement of the group of plants with which they are most familiar. Here and there a voice is raised against the continuance of this archaic system, and now and then one breaks his allegiance to Bentham and Hooker and becomes a disciple of Eichler, but the inconvenience, and the difficulties encountered in inaugurating the new system in the herbarium, and still more in the class room, have been sufficient practically to maintain the old system in our colleges, universities, herbaria, botanic gardens, and what is, of more importance, our text-books. There are to-day but one or two American text-books, and these quite elementary ones, in which the student can learn aught of any other than the prevailing Benthamian system. In the manuals which the student uses there is no hint as to the relationship of the groups. The beginner soon learns that families which are in juxtaposition are usually more or less related, but he meets with some puzzling cases as when he finds the Labiatæ, Plantaginaceæ and Nyctaginaceæ arranged side by side, with no word of explanation. Even in the more pretentious works, as in the "Synoptical Flora," and in the monographs of families, we have little if any discussion of the question of real relationship, its place being taken by a very little reference to what may be termed "descriptive affinity."

I may assume that it is well known to nearly all of us that the prevailing arrangement of the Dicotyledons does not represent the later views of any of the systematists. Bentham and Hooker distinctly state at the beginning of their treatment of the Apetalæ that the group is one neither natural nor well limited, and suggest in connection with many of the families their relationship to many Polypetalæ. While their arrangement follows the Candollean sequence, their explanatory notes show that the authors recognized the fact that the plants gathered in the group Apetalæ are reduced forms of Polypetalæ and Gamopetalæ.

Even so conservative a writer as Dr. Gray admits[1] that the prevailing system consists of "tenative groupings" of the families, and that "most apetalous flowers are reductions or degradations of polypetalous types." And yet a little later the same writer gives his adhesion to the Candollean system, in spite of the fact that he had declared[2] that viewed in the light of evolution "affinity is consanguinity, and classification in so far as it is natural, expresses real relationship." Here we have a principle of classification worthy of modern science, but a practice which abandons or ignores it. Thus he says[3] "the apetalous and achlamydeous must be the lowest," and describes them as "those plants which, with

Structural Botany (189), pp. 342. 344. [2] *Iibd*, p. 329. [3] *l. c.*

all their known relations, are most degraded or simplified by abortions and suppressions of parts which are represented in the complete flower." Commenting on these he says "These are low in structure, equally whether we regard them as reduced forms of higher types, or as forms which have never attained the full development and diversification which distinguish nobler orders." These remarks are closely followed by the presentation of a synoptical view[1] of the "present received" system.

The fact is, that the systematic disposition of the higher plants is at present a makeshift, maintained by conservatism and a reverence for the time-honored work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists, as a body, still adhered to the artificial system of Linné. As late as 1830, Lindley,[2] in urging the abandonment of the Linnean system, refers to the current objections to the natural system in these words: "Its uncertainty and difficulty deter us, say those, who acknowledging the manifest advantages of the natural system, nevertheless continue to make use of the artificial method of Linnæus."

It was not until 1833 that Beck gave us the first American Manual,[2] in which the natural system was adopted. Three years later Dr. Gray brought out his "Elements of Botany,"[3] and so common was the Linnean system that he devotes no less than eighteen pages to its full exposition. He finds it necessary, moreover, to argue at length that the Linnean system, while originally adopted by its founder as a temporary substitute for a natural system, had ceased to be necessary or useful, and to plead with those who would perpetuate it to consider whether the respect due to the system be not compromised "by permitting its degradation to purposes for which it was not originally designed."

Now sixty years later we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. His-

[1] "Introduction to the Natural System of Botany," p. xii.

[2] "Botany of the Northern and Middle States," by Lewis C. Beck. 1833.

[3] "Elements of Botany," by Asa Gray. New York, 1836.

tory repeats itself with such exactness, that with the change of a word here and there the arguments, pro and con, then used may be used to-day. The system of Jussieu and De Candolle is now as much a clog and a hinderance to the systematic botany of the higher plants, as was that of Linné sixty years ago; and now, as then, it is the spirit of conservatism and of veneration for time-honored usage which maintains the incubus.[1]

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which, as nearly as may be, represent primitive forms. Since the flower is a shoot, in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified, must be regarded as primitive, while that in which there is most modification must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome, is primitive and lower; the compound pistil is derived, and higher. The several-seeded compound ovary must be lower, and the compound ovary, with but one seed, must be higher. Separate stamens are primitive, united stamens, whether the union be with one another, or with other structures, must be derived, and consequently higher. So, too, when all parts of the flower are separate, it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants, it becomes evident that in the Dicotyledons, either the Apetalæ or the Polypetalæ must furnish our starting-point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought-for primitive types. Even a hasty examination of the thirty-six apetalous families, shows that they are at least, to a very large extent, derived from the Polypetalæ by the abortion of some parts and the entire omission of others. We may at once reject all of Bentham and Hooker's Series I, the Curvembryeæ, for we have here a much modified compound pistil, which with other structural peculiarities, shows them to be reduced from the Caryophylline type. Series II (Podostemaceæ), and III (Nepenthaceæ, Cytinaceæ, and Aristolochiaceæ) have compound pistils and must be rejected. In

[1] I have not deemed it necessary to refer to the position accorded to the Gymnosperms in most of our systematic works. It is so manifest an error as to need no discussion here. The flowering plants referred to in this paper are the Angiosperms, both Monocotyledons and Dicotyledons.

Series IV, the Piperaceæ have compound pistils, and the three remaining families, with simple pistils, are with little doubt to be regarded as reduced from the Ranunculine type. Series V (the Daphnales) may be transferred bodily to the Celastrales in the Polypetalæ, of which they are apparently reductions. The parasitic and parasitically-inclined members of Series VI (Loranthaceæ, Santalaceæ, and Balanophoreæ) are out of the question, being too evidently not of primitive type. The great aggregation of plants, brought together under Series VII and VIII, is composed almost entirely of forms with compound, and often much modified, pistils.

It appears, then, that when we search for families in the Apetalæ which may satisfy the requirements of a primitive group, from which the Dicotyledons may have evolved, we find none which will serve our purpose. The dictum of Dr. Gray[1], that "the apetalous and achlamydeous must be lowest," is not sustained. We must accordingly turn to the Polypetalæ, where we find all degrees of complexity from the Ranales, with all the parts of the flowers simple and separate, to the Umbellales with a compound, inferior, much modified gynœcium. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive Dicotyledons. This position was long ago suggested by the younger Jussieu,[2] who commenting on the fact that at that time most authors looking upon the flowers of the Ranunculaceæ and their relatives as more perfect than any other, would place them at the head of the vegetable kingdom,—argued, on the contrary, that the whole structure of the flower in those plants, and especially the easy passage from the organs of vegetation to those of reproduction, required that they must be assigned not only to a lower position, but to one exactly opposite to that which they usually occupied. He significantly indicates that the Compositæ, with a "precisely inverse" structure, should be regarded as the highest of the Dicotyledons.

The Ranales have distinct and separate perianth leaves (sepals and petals); the stamens are distinct, free from either perianth or pistils, and are mostly indefinite and many in number; the pistils are simple, free from the stamens or the perianth, and usually

[1] "Structural Botany," p. 343.
[2] "The Elements of Botany." Translated by Wilson. 1848, p. 543.

many; the ovules are many to few or one, and have two coats; the embryo is small and surrounded by a large endosperm. They satisfy very well the theoretical structure of a primitive dicotyledonous plant, and we may well use them as the point of departure for our system.

De Candolle, and his followers in phanerogamic morphology, took the flower of the Ranales as their typical or pattern flower, and built up a morphological system in which the underlying principle was the theory that all the forms of flowers are due to modifications of this archetype. We are all familiar with this treatment of the structure of the flower, as it is the one so clearly and ably set forth by Dr. Gray in his "Lessons" and "Structural Botany." In accordance with this morphology the Candollean sequence of the families of Dicotyledons was wrought out, the successive families showing greater and greater departures from the archetype. It is remarkable that this sequence, so established, did not more forcibly suggest what is now so plain that every man may read it—the greater principle of a genetic evolution. The old morphologists builded better than they knew, and though they did not understand it, gave us an arrangement of the principal polypetalous plants which accords wonderfully with our present knowledge of the evolution of living things. Yet, they interpreted departure from the type or pattern flower as a lower modification, and at first made a descending series.

We may, then, in the light of evolution accept in general the Candollean plan of arrangement of the Polypetalæ, as wrought out by Bentham and Hooker in their "Genera Plantarum," and adapt it to the new view, with comparatively few changes. The apetalous families may be assigned to places near those to which they are evidently related, and if any remain whose relationship cannot be made out, they may be placed in some such convenient limbo as the "Ordines Anomali" of Bentham and Hooker, or the suggestive "Anhang" of the German botanists.

Our system then begins with the Ranales, to which we have added the small families Myristicaceæ, Monimiacedæ, and Chloranthaceæ. The Parietales, Polygalales, and Caryophyllales follow, the latter much increased by the apetalous families of the so-called Curvembryeæ, and the Salicaceæ from Bentham and Hooker's "Ordines Anomali." The Guttiferales and Malvales close the Thalamifloral series, but the latter group has been greatly increased by the addition of a number of apetalous families, viz., Piperaceæ, Euphorbiaceæ, Balanopseæ, Empetraceæ, Urticaceæ, Leitneriaceæ.

In the Discifloræ, which originate near the Ranales, we have (1) the Geraniales; (2) the Celastrales (in the wider sense, including Olacales), to which are now added the apetalous Daphnales, and Achlamydosporeæ; and (3) the Sapindales, to which have been added the apetalous Juglandaceæ, Cupuliferæ, and Myricaceæ, and possibly the Casuarineæ.

Going back again to the vicinity of the Ranales, we find the initial point from which the Calycifloral series develops through the Rosales, to the Myrtales, Passiflorales, Cactales, and Umbellales, the highest of the polypetalous plants.

A careful study of the Gamopetalæ, while showing that they rank higher than Polypetalæ, brings out the fact that the group is not a single one, and has probably arisen by development along, at least, two lines. From the Caryophyllales in the Thalamifloræ, the small series Heteromeræ came off, including the Ericales, Primulales, and Ebenales, and these connect with the Bicarpellatæ, composed of the Gentianales, Polemoniales, Personales, and Lamiales. From the summit of the Calcyfloræ we pass easily to the Inferæ, reaching first the Rubiales, which connect equally with the Campanales and Asterales, the last the highest of the Dicotyledons.

A similar examination of Bentham and Hooker's monocotyledonous groups, which they name "series," shows that the sequence which they adopt gives no idea of their probable method of evolution. Here their series Apocarpæ (Alismales), so strikingly like the Ranales of the Dicotyledons, is without doubt the primitive one, and this leads easily to their Coronarieæ (the Liliales of other authors). From this central group two diverse sets of branches have developed, the one with a superior, and the other an inferior compound ovary. In the hypogynous branches there is at once a reduction in the parts of the flower, as is well shown in the Nudifloræ (Arodiales), and Calycinæ (Palmales), culminating in the Glumaceæ (Glumales), which have so far departed from the lily type that at first sight it is difficult to see any relationship. The other branch passes by easy steps through the Epigynæ (Iridales) to the Microspermæ (Orchidales).

Such a system as is here briefly outlined, while it cannot hope to be free from grave errors, may yet claim for itself that it is an attempt at such an arrangement of the families of flowering plants as would be in harmony with the doctrine of evolution.

May I beg of you that you will not underrate the importance of a general system, and I hardly need to remind you that unless the families of plants are arranged in accordance with some system, our classification is arbitrary and artificial. The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific, because it absolutely fails to conform to the law of evolution. We must abandon the old classification and attempt one, which in the light of evolution, is rational. Let us not cling to the old because it is inconvenient to change—let us not cling to it through a mistaken reverence for the practice of the fathers—let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old, when the old is no longer the true; it tears down the work of years, when that work no longer represents the truth; and it dares to reach out and frame a rational system, even though some parts of it, for a time, rest upon hypothetical grounds.

A REVISED ARRANGEMENT OF THE BENTHAMIAN "SERIES" OF FLOWERING PLANTS.

Sub-class Monocotyledones.

Apocarpæ. (Alismales.)
Alismaceæ, Triurideæ, Naiadaceæ.

Coronarieæ. (Liliales.)
Roxburghiaceæ, Liliaceæ, Pondeteriaceæ, Philydraceæ, Xyridaceæ, Mayaceæ, Commelinaceæ, Rapateaceæ.

Nudifloræ. (Aroidales.)
Pandanaceæ, Cyclanthaceæ, Typhaceæ, Aroideæ, Lemnaceæ.

Calycinæ. (Palmales.)
Flagellarieæ, Juncaceæ, Palmaceæ.

Glumaceæ. (Glumales.)
Eriocauleæ, Centrolepideæ, Restiaceæ, Cyperaceæ, Gramineæ.

Hydrales.
Hydrocharideæ.

Epigynæ. (Iridales.)
Dioscoreaceæ, Taccaceæ, Amaryllidaceæ, Iridaceæ, Hæmodoraceæ, Bromeliaceæ, Scitamineæ.

MICROSPERMÆ. (Orchidales.)
Burmanniaceæ, Orchidaceæ.

SUB-CLASS DICOTYLEDONES.

Polypetalæ. (*Choripetalæ.*)

THALAMIFLORÆ. Hypogynous, apocarpous, or syncarpous.
Ranales.
Ranunculaceæ, Dilleniaceæ, Calycanthaceæ, Magnoliaceæ, Anonaceæ, Myristicaceæ, Monimiaceæ, Chloranthaceæ, Menispermaceæ, Berberidaceæ, Nymphaeaceæ.
Parietales.
I. Sarraceniaceæ, Papaveraceæ, Cruciferæ, Capparidaceæ, Resedaceæ, Cistaceæ, Violaceæ, Canellaceæ, Bixaceæ,
II. Nepenthaceæ.
Polygalales.
Pittosporaceæ, Tremandraceæ, Polygalaceæ, Vochysiaceæ.
Caryophyllales.
I. Frankeniaceæ, Caryophyllaceæ, Portulacaceæ, Tamariscaceæ, Ficoideæ.
II. Nyctaginaceæ, Illecebraceæ, Amarantaceæ, Chenopodiaceæ, Phytolaccaceæ, Batideæ, Polygonaceæ.
III. Salicaceæ.
Guttiferales.
Elatineæ, Hypericaceæ, Guttiferæ, Ternstrœmiaceæ, Dipterocarpeæ, Chlænaceæ.
Malvales.
I. Malvaceæ, Sterculiaceæ, Tiliaceæ.
II. Euphorbiaceæ, Balanopseæ, Empetraceæ.
III. Urticaceæ, Platanaceæ, Leitneriaceæ, Ceratophyllaceæ.
IV. Piperaceæ (?), Podostemaceæ.

DISCIFLORÆ. Hypogynous, syncarpous.
Geraniales.
Linaceæ, Humiriaceæ, Malpighiaceæ, Zygophyllaceæ, Geraniaceæ, Rutaceæ, Simarubaceæ, Ochnaceæ, Burseraceæ, Meliaceæ, Chailletiaceæ.
Celastrales.
I. Olacaceæ, Ilicineæ, Celastraceæ, Stackhousieæ, Rhamnaceæ, Ampelideæ.
II. Lauraceæ, Proteaceæ, Thymelæaceæ, Penæaceæ, Elæagnaceæ.
III. Santalaceæ, Loranthaceæ, Balanophoraceæ.
Sapindales.
I. Sapindaceæ, Sabiaceæ, Anacardiaceæ.
II. Juglandaceæ, Myricaceæ, Cupuliferæ.

III. ? Casuarinaceæ.

CALYIFLORÆ. Epigynous, syncarpous.

Rosales.

Connaraceæ, Leguminosæ, Rosaceæ, Saxifragaceæ, Crassulaceæ, Droseraceæ, Hamamelidaceæ, Bruniaceæ, Halorageæ.

Myrtales.

I. Rhizophoreæ, Combretaceæ, Myrtaceæ, Melastomaceæ, Lythraceæ, Onagraceæ.

II. ?Aristolochiaceæ, Cytinaceæ.

Passiflorales.

Samydaceæ, Loasaceæ, Turneraceæ, Passifloraceæ, Cucurbitaceæ, Begoniaceæ, Datiscaceæ.

Cactales.

Cactaceæ.

Umbellales.

Umbelliferæ, Araliaceæ, Cornaceæ.

Gamopetalæ.

HETEROMERÆ. Ovary, mostly superior.

Primulales.

Plumbaginaceæ, Plantaginaceæ, Primulaceæ, Myrsinaceæ.

Ericales.

Vacciniaceæ, Ericaceæ, Monotropeæ, Epacrideæ, Diapensiaceæ, Lennoaceæ.

Ebenales.

Sapotaceæ, Ebenaceæ, Styracaceæ.

BICARPELLATÆ. Ovary mostly superior; stamens and petals isomerous; ovary, bi-carpellary.

Gentianales.

Oleaceæ, Salvadoraceæ, Apocynaceæ, Asclepiadaceæ, Loganiaceæ, Gentianaceæ.

Polemoniales.

Polemoniaceæ, Hydrophyllaceæ, Boraginaceæ, Convolvulaceæ, Solanaceæ.

Personales.

Scrophulariaceæ. Orobanchaceæ, Lentibulariaceæ, Columelliaceæ, Gesneraceæ, Bignoniaceæ, Pedaliaceæ, Acanthaceæ.

Lamiales.

Myoporineæ, Selagineæ, Verbenaceæ, Labiatæ.

INFERÆ. Ovary inferior, stamens and petals isomerous.

Rubiales.

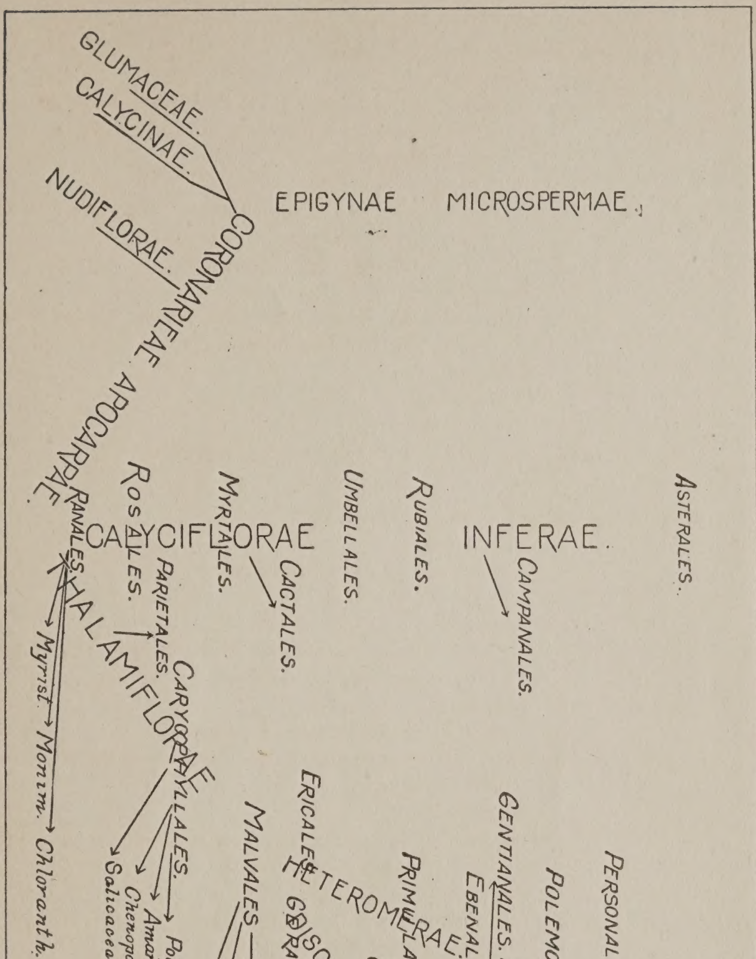
Caprifoliaceæ, Rubiaceæ.

Campanales.

Stylidaceæ, Goodenovieæ, Campanulaceæ.

Asterales.

Valerianaceæ, Dipsaceæ, Calyceraceæ, Compositæ.



DIAGRAMMATIC REPRESENTATION OF THE RELATIONSHIP OF THE SERIES OF FLOWERING PLANTS.